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Is There a Place for Endovascular Treatment in Aortic Arch Pathology?

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ABSTRACT

BACKGROUND: Aortic arch stenting appears to be a debatable topic among cardiac surgeons, cardiologists and interventional radiologists. During the last decade a variety of products of endovascular treatment has been applied either to open heart surgery or to hybrid management of aortic arch pathology. In general, fenestrated, bare and multilayer stents are separate issues to be investigated, in contrary to covered stents which seem to gain their place in cardiovascular operations. Additionally new sophisticated devices and methods derived from current literature, e.g. Djumbodis, E-xl, BOS, Frozen elephant trunk (EVITA OPEN), & Cardiatis, promote the idea of hybrid treatment of aortic arch pathology.

AIM, METHODS & RESULTS: The primary purpose in our presentation is to discuss several aspects of aortic arch stenting and to investigate the possibility of performing less invasive operations by the use of evolutionary facilities in order to define the spectrum of indications and to improve decision making. Currently there is no adequate evidence (level A or B) to develop guidelines for the management of acute aortic syndromes and thoracic aneurysms. According to several articles in the literature, endovascular interventions and hybrid repairs seem to approach or even to decrease the rate of mortality and morbidity in comparison to open surgical procedures and medical treatments. On the other hand, many reports in current literature indicate that conventional aortic arch surgery or conservative treatment are superior to stenting, thus creating a foggy field for a well established decision making.

CONCLUSION: Thus, for endovascular or hybrid treatment of aortic arch pathology, these new technological entities in pair to previous applied methods should be studied further in multicenter prospective randomized trials in order to create a safe treatment environment.

KEY WORDS: *aortic arch; aortic stenting; aortic aneurysm; dissection of aorta*

ABBREVIATIONS

DHCA= deep hypothermic circulatory arrest

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INTRODUCTION

Aortic arch stenting appears to be a debatable topic among cardiac surgeons, cardiologists and interventional radiologists. Over the last decade a variety of products of endovascular treatment has been applied either to open heart surgery, endovascular or hybrid management of aortic arch pathology.

OPEN SURGICAL RESULTS

Until recently the only available therapeutic option for the aortic arch pathology was the traditional open surgical procedure with cardiopulmonary bypass and deep hypothermic circulatory arrest (DHCA). In the last decade many efforts from scientists aim to import endovascular methods and treatments in the realm of the synchronous cardiac surgeon and cardiologist. Does the conventional open surgery need the endovascular component of treatment to be improved?

First of all we have to appreciate the results of classic open surgery. The majority of studies in aortic arch surgery report mortality between 6.3-16.5% and an incidence of stroke between 6.7-18%. Especially the incidence of stroke depends on the duration of circulatory arrest and is defined at 13.8% if you have less than 30 min of DHCA and 37.9% if you have more than 30 min of DHCA.¹

Let's see the surgical results in a contiguous area. What is happening if the aortic pathology extends from the arch to the descending aorta? Really impressive results have published by Kouchoukos NT et al.² They treated 51 patients with chronic expanding thoracic aortic dissections (48 type A, 3 type B with proximal extension) with a single procedure using a bilateral anterior thoracotomy, hypothermic circulatory arrest, and reperfusion of the arch vessels first, to minimize brain ischemia. Hospital mortality was 3.9%. No patient sustained a stroke. The conventional approach using the elephant trunk technique (two-stage procedure) has been studied in many centers for many years. Again from the U.S.A, Etz CD et al³ reported mortality of 6.5% for the first stage and 7.5% for the second stage. The overall cumulative survival, including patients dying before or without stage two, was 69% after 1 year and 55% after 5 years.

In general, open procedures are well established and their results are satisfactory. But can we achieve even better results than those obtained via the open procedures? Zipfel et al⁴ (Deutsches Herzzentrum Berlin) published a case report which concerned a 22-year-old man with Marfan's syndrome and ascending aorta aneurysm with type B dissection, and an abdominal aorta aneurysm. On January 1993, the patient underwent replacement of ascending aorta and aortic root (Cabrol technique). After 2 months he was submitted to replacement of the descending aorta, and after 4 months to replacement of the abdominal aorta with concomitant aorto-iliac bypass. All the surgical procedures were completely successful. Unfortunately, 3 months later the patient was dependent on biventricular assist device which eventually bridged him to heart transplantation. The conduction of this multifold surgical course was completely successful but the patient would have died without a new heart. Thus conventional surgery has its endogenous problems which derive from the invasive character of the procedure and from the aggressive manner

the patient is managed. So at least we have to appreciate and estimate the new endovascular modalities.

ENDOVASCULAR TREATMENT OF AORTIC ARCH

COVERED STENTS

Which are the current endovascular treatments which are available and have been used by many physicians? Aortic arch stenting following aortic arch debranching (extra-anatomic bypasses) is an applied method in many centers worldwide, especially, for high risk patients. Substantially this is a hybrid method which combines both surgical (debranching- extra anatomic bypass) and endovascular treatment (stent grafting) with covered stents. Follow up studies of such extra-anatomic bypasses have demonstrated patency rates of 88% at 3 years and 84% at 5 years.¹ The academic teaching hospital Hanau from Germany (Schumacher et al⁵) reported that the overall perioperative 30-day mortality was 20% in high risk patients who were excluded by cardiac surgeons as ineligible for conventional arch repair. Melissano et al⁶ operated on 42 patients and published their results. They report mortality at 30 days of 6.3%, stroke 3.1%, and paraparesis or paraplegia 3.1% including not only high risk patients.

FENESTRATED AND BRANCHED STENTS

An alternative which has been proposed to address this issue is fenestration and branch technology. This technology has been applied to thoracoabdominal aneurysms widely, but there is no application in aortic arch pathology with the exception of very few cases worldwide, which concern partial or distal arch pathology and not the entire arch. Also there exist few experimental data in animals and cadavers.

MULTILAYER STENT

A big issue in current era is the new technological development which is called multilayer stent (cardiatis). This endovascular "gadget" claims that it slows and laminates blood flow inside the aneurysm, minimizing possibilities of aneurysm rupture and allowing an organized thrombus to form. The most important and exciting part is that it allows and preserves blood flow to the branches. This aneurysm repair system has received CE-mark approval in Europe for peripheral artery disease. The first treated patient was a 78-year-old male in Greece who underwent a minimally invasive endovascular procedure that placed a cardiatis stent to treat a large renal artery saccular aneurysm with side branches by Michel Henry and Antonios Polydorou.⁷ The 7-month follow-up angiogram confirmed reduction in aneurysm size, collapse of the aneurysmal sac and preservation of flow in vital collateral circulation with open and functional branches. The same success had a popliteal aneurysm treated the same way in Greece by Poly-

dorou (personal communication). A month ago the same stent was used with success to treat a thoracoabdominal aneurysm by Polydorou and Kokotsakis in a patient who was enrolled in a protocol investigating the use of this type of stent (personal communication). The future will show if this modality proves to be a long term durable and effective technique.

UNCOVERED STENTS

A big chapter of aortic arch pathology is acute aortic syndromes including dissections. For this portion of aortic diseases two new sophisticated devices are now available to be added in our therapeutic armamentarium: the Djumbodis dissection system from Saint Come and the E-XL device from Jotec. These new modalities are uncovered stents which can be placed in the aortic arch in combination with open surgical replacement of the ascending aorta mostly in cases of acute aortic dissection type A. The purpose of this hybrid management is to reduce the invasiveness of the whole procedure and consequently the attendant morbidity and mortality. A published abstract by Ius et al⁸ (23rd EACTS Annual Meeting, Vienna Austria, October 2009) concludes that placement of this type of stents seems to obtain, early postoperatively, a more favourable, albeit not significant, ratio between descending aorta and true lumen. Another study from Toulouse by Leobon et al⁹ indicates that the use of these devices can achieve reduction in number of perfused false lumen of aortic arches, more often stented, than for descending aortas and for dissected and stented segments versus dissected unstented segments.

BRANCHED OPEN STENT GRAFTING TECHNIQUE

The same rationale of reduced invasiveness and hybrid management has the branched open stent grafting technique, which has been described by Shimamura et al¹⁰ from Osaka University Graduate School of Medicine in Japan. According to this technique, home-made branched endoprosthesis reconstructs the descending aorta and aortic arch with its cervical branches, simultaneously in a single sort circulatory arrest period through the opened proximal aortic arch thus, completing total arch repair by the same aortic incision line as the hemiarch repair. The Japan group performed this technique in 69 cases and reports 30-day mortality of 4.3%, incidence of stroke 5.8% and of spinal cord injury 2.9%. The survival rate was 90.9%, 88.8% and 88.8% the first, second and third year respectively. A 5% of the cervical stent grafts showed endo-leakage and were treated by additional endovascular repair. To the aforementioned stents one can add the E-Vita open plus (frozen elephant trunk) and the E-Vita proximal endoprostheses which are uncovered along the major curve of the arch and covered along the minor curve which allows blood flow to the branches of aortic arch.

DISCUSSION

It becomes clear from the aforementioned that thoracic endovascular therapies are unlimited. For almost every aortic pathology, there exists an endovascular or hybrid approach which promises less invasiveness. On the other hand, even in the most widely applied endovascular field which is the descending thoracic aorta, there is no level A or B evidence (results from prospective randomized trials) to compare medical therapy with surgical intervention, or the results of open procedures with endovascular stent graft procedures as this is noted in the STS Expert Consensus Document. Possibly Dietrich from the Arizona Heart Institute was accurate when he was saying in a lecture held in Athens 3 years ago, that practically there is no consensus on these issues. Let's analyse some studies and some important aspects.

Recently, Buz et al¹¹ published a retrospective study of 74 patients with acute traumatic aortic rupture. Among them, 35 underwent surgical repair and 39 underwent endograft implantation. Hospital mortality was 20% in the surgical group and 7.7% in the endovascular group. The mean age of the patients was 36 years. So, is the endovascular treatment the winner? What happens with the long term durability of these stents? Stents have been designed to have a durability of ten years based on ISO stress testing. The majority of patients with traumatic aortic rupture are young people who will live 30 to 60 years with their implanted stent. On a different note, impressive results come from a study of Kieffer et al¹² from Paris who repaired descending thoracic aortic aneurysms. A total of 52 patients underwent endovascular stent graft repair (group 1). Endovascular repair was carried out exclusively in high surgical risk patients in whom preoperative spinal cord arteriography usually demonstrated that the origin of the Adamkiewicz was located outside the covered zone. Another 121 patients underwent open surgical repair. Hospital mortality was 15.4% for the endovascular group and 5% for the surgical group.

The majority of published reviews of thoracoabdominal aneurysm repairs via endovascular approach report results which are favourable compared to open surgery in high risk patients. Unfortunately, we do not have long term results, which are necessary to evaluate specific complications such as migration, material fatigue and component separation, that can result in loss of visceral branches and thus in an increased delayed morbidity and mortality. Consequently, we do have available technological developments, modalities, techniques and "smart" devices but we do not have basic principles on which we would consolidate an applied evidence based medicine. A potentially basic principle which concerns aortic pathology is that false lumen patency predisposes for late aorta related events. However, Juvonen et al¹³ conclude that neither the presence of a persistently patent false lumen

nor a large abdominal aortic diameter appears to increase the risk of rupture. On the other hand, Marui et al¹⁴ state that the degree of fusiform dilatation of the proximal descending aorta, a patent false lumen and a large aortic diameter are the predominant predictors of late aortic events in patients with type B acute aortic dissection.

The majority of reports contemplate the patent false lumen as the main culprit for the progress of the disease. This was the rationale on which the planning and the conduction of the INSTEAD trial was based. In this study, Nienaber et al¹⁵ investigated the outcome after endovascular aortic repair (EVAR) in uncomplicated acute type B dissections. Although aortic remodeling, with true lumen recovery and false lumen thrombosis, occurred in 91.3% of patients with EVAR versus 19.4% of those who received medical treatment, the trial failed to prove any 2-year survival benefit for the EVAR group.

Undoubtedly, endovascular treatment is the future, is attractive, sometimes easier and faster but it is not a panacea and has its own limitations. It necessitates intensive follow up for life and often requires re-interventions. Open repairs seem to remain durable over the long term and do not require multiple re-interventions. Possibly the issue is similar to the debate between CABG and coronary artery stenting. The accessibility and the convenience of endovascular modality should not impel physicians to overuse. Endovascular treatment presupposes wisdom judgment. The STS Expert Consensus Document on the treatment of descending thoracic aortic disease using endovascular stent grafts underlines: "Elderly patients who have multiple additional medical conditions, that handicapped their quality of life, because stent grafting does not improve quality of life in asymptomatic patient, the logic of proceeding with an invasive intervention to prevent aneurysm rupture in patients who are approaching the end of their expected biological lifespan is not persuasive".

CONCLUSION

For the endovascular treatment of aortic arch pathology, the various technological new entities in pair to previously applied methods should be studied further in multicenter prospective randomized trials in order to create a safe therapeutic environment.

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